

**Draft Recommendation for
Space Data System Standards**

**SPACE LINK
IDENTIFIERS**

DRAFT RECOMMENDED STANDARD

CCSDS 135.0-P-3.1

PINK SHEETS
December 2008

1.6 DEFINITIONS

For the purposes of this Recommendation, the following definitions apply. Many other terms that pertain to specific items are defined in the appropriate sections.

Assigned by CCSDS: values of the identifier are assigned by CCSDS upon request by Agencies.

Defined by CCSDS: values of the identifier are defined by CCSDS as part of the specification of protocol.

Managed by projects: values of the identifier are managed independently by the projects that use the protocol.

space link: a communications link between a spacecraft and its associated ground system, or between two spacecraft.

space link protocol: a communications protocol designed to be used over a space link (see above). A space link protocol is not necessarily a protocol of the Data Link Layer of the OSI Basic Reference Model (reference [1]).

1.7 CONVENTIONS

In this document, the following convention is used to identify each bit in an N -bit field. The first bit in the field to be transmitted (i.e., the most left justified when drawing a figure) is defined to be 'Bit 0'; the following bit is defined to be 'Bit 1' and so on up to 'Bit $N-1$ '. When the field is used to express a binary value (such as a counter), the Most Significant Bit (MSB) shall be the first transmitted bit of the field, i.e., 'Bit 0' (see figure 1-1).

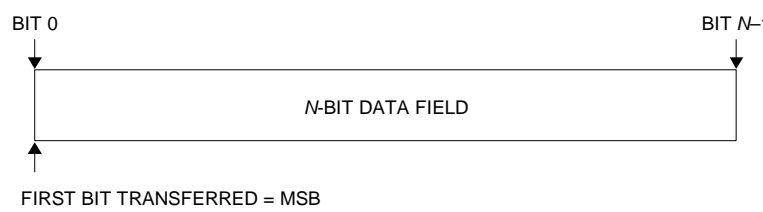


Figure 1-1: Bit Numbering Convention

In accordance with standard data-communications practice, data fields are often grouped into eight-bit 'words' which conform to the above convention. Throughout this Recommended Standard, such an eight-bit word is called an 'octet'.

The numbering for octets within a data structure starts with zero. By CCSDS convention, all 'spare' bits shall be permanently set to '0'.

- [12] *CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures*. Recommendation for Space Data System Standards, CCSDS 320.0-B-4. Blue Book. Issue 4. Washington, D.C.: CCSDS, January 2006.
- [13] *Encapsulation Service*. Recommendation for Space Data System Standards, CCSDS 133.1-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, June 2006.
- [14] *TM Synchronization and Channel Coding*. Recommendation for Space Data System Standards, CCSDS 131.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [15] *TC Synchronization and Channel Coding*. Recommendation for Space Data System Standards, CCSDS 231.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2003.
- [16] *Information Technology—Protocol for Providing the Connectionless-Mode Network Service: Protocol Specification*. International Standard, ISO/IEC 8473-1:1998. 2nd ed. Geneva: ISO, 1998.
- ~~[17] J. Postel. *Internet Protocol*. STD 5, September 1981. [RFC 791, RFC 950, RFC 919, RFC 922, RFC 792, RFC 1112]⁺~~
- ~~[18] S. Deering and R. Hinden. *Internet Protocol, Version 6 (IPv6) Specification*. Draft Internet Standard, December 1998. [RFC 2460]~~
- [17] J. Postel. *Internet Protocol*. STD 5. Reston, Virginia: ISOC, September 1981.
- [18] S. Deering and R. Hinden. *Internet Protocol, Version 6 (IPv6) Specification*. RFC 2460. Reston, Virginia: ISOC, December 1998.
- [19] M. Degermark, B. Nordgren, and B. Nordgren. *IP Header Compression*. RFC 2507. Reston, Virginia: ISOC, February 1999.
- [20] S. Casner and V. Jacobson. *Compressing IP/UDP/RTP Headers for Low-Speed Serial Links*. RFC 2508. Reston, Virginia: ISOC, February 1999.

NOTE – Informative references are listed in annex C.

⁺ ~~Internet Request for Comments (RFC) texts are available on-line in various locations (e.g., <http://ietf.org/rfc/>); Internet standards are made up of one or more RFCs, which are identified in square brackets following the entry.~~

Table 7-7a: Defined Protocol Identifiers

Protocol Identifier (binary)	Protocol	Reference
000	Fill (the encapsulation data field, if present, contains no protocol data)	N/A
001	Reserved by CCSDS	N/A
010	IP Version 4 Internet Protocol Extension (IPE)	[17] annex A
011	CFDP	[4]
100	IP Version 6 Reserved by CCSDS	[18] N/A
101	Reserved by CCSDS	N/A
110	Protocol Extension (signals the use of the Extended Protocol ID for Encapsulation Service)	[13]
111	Arbitrary Aggregations of Octets	N/A

Table 7-7b lists the Extended Protocol Identifiers defined for the Encapsulation Service by CCSDS.

Table 7-7b: Extended Protocol Identifiers

Protocol Identifier (binary)	Protocol	Reference
0000 through 1111	Reserved by CCSDS	N/A

ANNEX A

CCSDS IP EXTENSION (IPE)

(NORMATIVE)

A1 PURPOSE AND SCOPE

This annex specifies the CCSDS Internet Protocol Extension (IPE) convention.

A2 OVERVIEW

A2.1 GENERAL

The primary purpose of the CCSDS Internet Protocol Extension (IPE) convention is to provide an interoperable way of identifying the Internet protocols being encapsulated by the CCSDS Encapsulation Service (reference [13]) when this service is being used to provide a data link layer for the Internet Protocol (IP). This protocol convention uses one and optionally more than one shim byte to extend the CCSDS Encapsulation packet header. See table A-1 for recommended protocols to be encapsulated and their enumerations.

Using this convention, the Encapsulation service provides a data link layer for IP. It supports IP packet formats shown in table A-1. IPE uses the Encapsulation service primitives defined and the service described in reference [13]. The additional service provided through the IPE is a protocol multiplexing/demultiplexing capability.

The IPE convention allows demultiplexing of subprotocols used in IP. It offers a sizable protocol identifier space while not impacting the protocol ID space used by the Encapsulation Service itself. This abstracts, and allows the separation of, protocols originally supported by the Encapsulation Service and IP data transfer over it. No additional processing is performed at the multiplexing/demultiplexing layer affiliated with the IPE convention. The multiplexing/demultiplexing services know nothing of the formats or conventions of the protocols they are multiplexing or demultiplexing.

NOTE – The Relationship of IPE to the Encapsulation Service is shown in figure A-1.

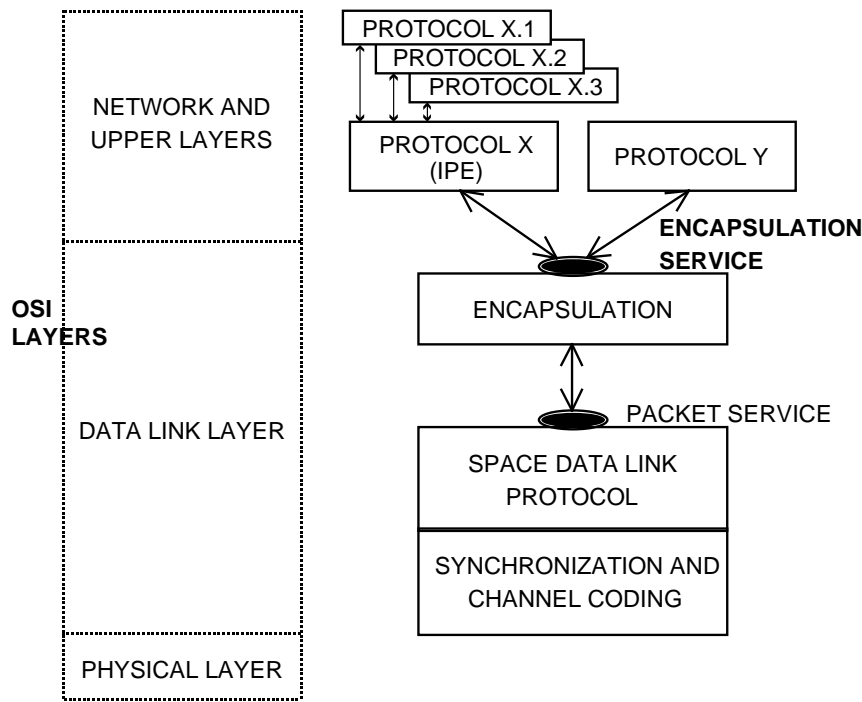


Figure A-1: Relationship of IPE to the Encapsulation Service

A2.2 IPE HEADER ENUMERATIONS AND MAPPINGS

There often are many IP data types that require encapsulation. The exact number of protocols depends on the mission and its requirements. These protocols are fully defined in other data standards. Thus the intent here is to identify only auxiliary Protocol Data Unit (PDU) formats that are often used in support of IP. As a comparison, serial links between routers often carry the 16-bit PPP protocol field, and the Ethernet protocol data units carry a 16-bit Ethernet type field. In these cases, the enumerations of the protocols are defined by Internet Assigned Numbers Authority (IANA) and the Institute of Electrical and Electronics Engineers (IEEE) respectively. The tables containing the enumerations then point to the standards that define the protocols themselves.

The alternate approach would have been to encapsulate a conventional link layer, such as Multiprotocol over Frame Relay, and use its methods for identifying the auxiliary PDU formats.

Auxiliary protocols nominally identified at the data link layer in support of IP include IPv4, IPv6, IP compressed header formats, the address resolution protocol for multi-access link layers, link layer control protocols including link metrics exchange and link health monitoring, various link and network layer configuration protocols, and authentication protocols.

Addressing and routing protocols often tie into these protocols via initial configuration exchanges and link state up/down information. It should be noted, however, that routing

protocols such as Open Shortest Path First (OSPF), Protocol-Independent Multicast (PIM), and Border Gateway Protocol (BGP) also maintain their own adjacency or state via hello exchanges or refreshes at the network layer.

Most of these protocols are built around bi-directional links and require bi-directional exchanges. Since in the space environment it is expected that network layer protocols will have to be able to use one-way links, it is not recommended that these protocols be required. It is believed that if fairly simple networks are involved, and they are monitored in a transparent manner, it is possible to use pre-arranged static settings rather than dynamic exchanges to verify and maintain correct configuration. However, if appropriate for the mission, use of these protocols is not prohibited.

A3 INTERNET PROTOCOL EXTENSION SPECIFICATION

A3.1 GENERAL

A3.1.1 The IP PDU to be encapsulated shall follow, without gap, the IPE header.

A3.1.2 The concatenation of IPE Header and IP PDU shall be the Data Unit parameter of the Encapsulation Service (see reference [13], section 3).

NOTES

- 1 The Encapsulation packet length field in the Encapsulation packet header consists of the sum of the sizes of the Encapsulation Packet header, the IPE header, and the PDU to be encapsulated.
- 2 The format and placement of the IPE header are shown in figure A-2.

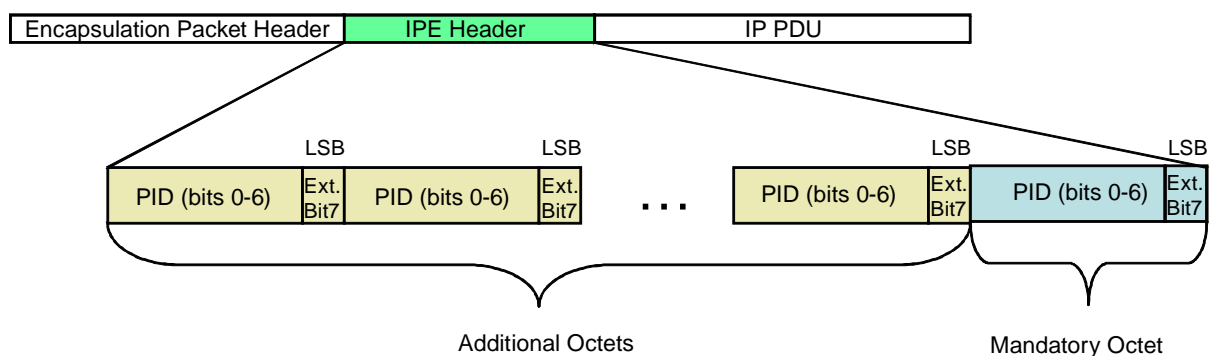


Figure A-2: IPE Header Format and Placement

A3.2 INTERNET PROTOCOL EXTENSION HEADER

A3.2.1 The IPE header shall be an integral number of octets in length, with a minimum length of one octet.

A3.2.2 Bit and octet ordering of the IPE header shall follow the conventions given in 1.7.

A3.2.3 Every Octet in the IPE header consists of two fields:

- Bits 0 through 6: Most Significant Bits of the Protocol ID (PID);
- Bit 7: Least Significant Bit (LSB) of the PID is the Header Extension Bit.

A3.2.4 The IPE header shall be extendable by adding more significant octets to the first octet. The use of one or more additional octets is signaled by setting the LSB of each octet of the header except the final (least significant) octet to '0'; the LSB of the IPE header shall be set to '1'.

EXAMPLE – For an IPE header value of 33 (decimal) for a two octet header, the most significant octet would contain all zeros.

A3.2.5 The IPE header shall be interpreted as an unsigned integer value, per the convention given in 1.7.

A3.2.6 The IPE Header shall contain one of the values given in table A-1.

Table A-1: Enumerations for the IPE Header Values

IPE Header Value	Protocol Encapsulated	Reference
33	IPv4 datagram	[17]
87	IPv6 datagram	[18]
97	FULL_HEADER	[19]
99	COMPRESSED_TCP	[19]
101	COMPRESSED_TCP_NO_DELTA	[19]
103	COMPRESSED_NON_TCP	[19]
105	COMPRESSED_RTP_8	[20]
107	COMPRESSED_RTP_16	[20]
109	COMPRESSED_UDP_8	[20]
111	COMPRESSED_UDP_16	[20]
113	CONTEXT_STATE	[19], [20]

NOTES

- 1 The IPE Header is an extension to the Encapsulation Packet header in that it effectively expands the number of IP protocols that can have a standardized definition for transport over CCSDS space data links.
- 2 Since the most significant octets occur first, octets with the value of zero are effectively fill octets.
- 3 All IPE header numbers will by definition be odd. A consequence of signaling additional octets in the IPE Header by setting the extension bit to '0', results in discontinuities in the IPE header value.
- 4 To support the IPE header, processing and parsing of the header is required. Besides multiplexing and demultiplexing, which can subsequently involve stateless mapping between link layer conventions used on other link layers, no additional processing is intended. Such processing would be considered to be specific to the protocols that are identified via this header.

ANNEX B

ACRONYMS

(This annex **is not** part of the Recommendation)

This annex lists the acronyms used in this Recommendation.

AOS	Advanced Orbiting Systems
APID	Application Process Identifier
BGP	Border Gateway Protocol
CCSDS	Consultative Committee for Space Data Systems
CFDP	CCSDS File Delivery Protocol
CLCW	Communications Link Control Word
D-ID	Domain Identifier
ES-ID	End System Identifier
IANA	Internet Assigned Numbers Authority
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISO	International Organization for Standardization
MAP	Multiplexer Access Point
N/A	Not Applicable
OSPF	Open Shortest Path First
PDU	Protocol Data Unit
P-ID	Path Identifier
PIM	Protocol-Independent Multicast
Prox	Proximity-1 Space Link Protocol
SCID	Spacecraft Identifier
SCPS	Space Communications Protocol Standards
SCPS-FP	Space Communications Protocol Standards File Protocol
SCPS-NP	Space Communications Protocol Standards Network Protocol
SCPS-SP	Space Communications Protocol Standards Security Protocol